

A Preliminary Look at Arctic Feedbacks

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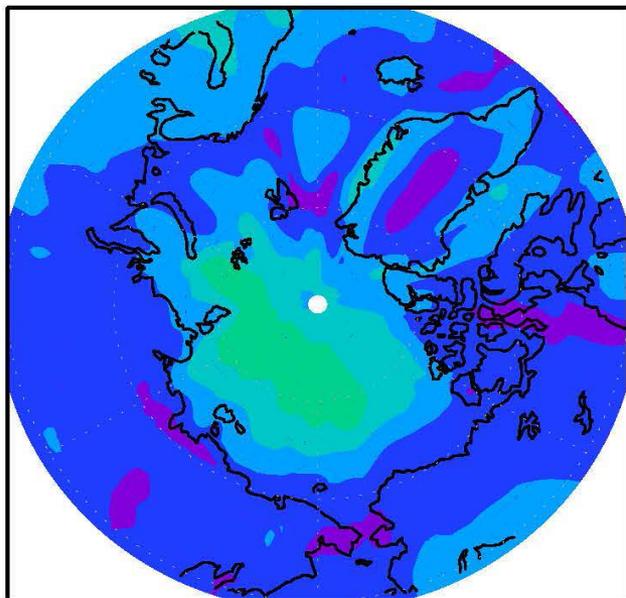
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Why look at the Arctic?

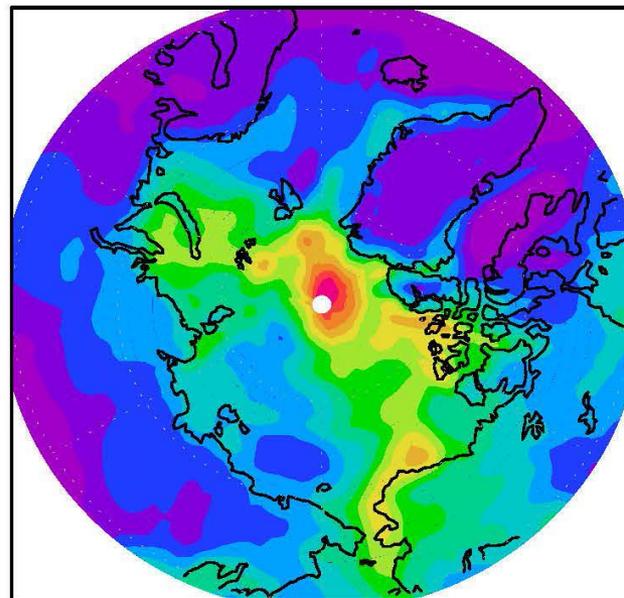
- No comprehensive studies on arctic feedbacks.
 - Most focus on ice/snow feedbacks and their contribution to global ΔT_s (e.g., Winton 2006).
 - Others focus on just a single model - primarily NCAR CCSM (e.g., Kay et al. 2012).
- Arctic feedbacks are not important globally, but are locally.
 - Arctic feedbacks are not important for global climate sensitivity (only ~2% of surface area)
 - Do have large impact locally with important ecological and socioeconomic implications.
- Region of very rapid changes in climate which have strong local feedbacks.
 - Possible to observe feedback processes within a single CLARREO mission?
- Good sampling from polar orbiting satellites

CMIP5 Ensemble-Mean

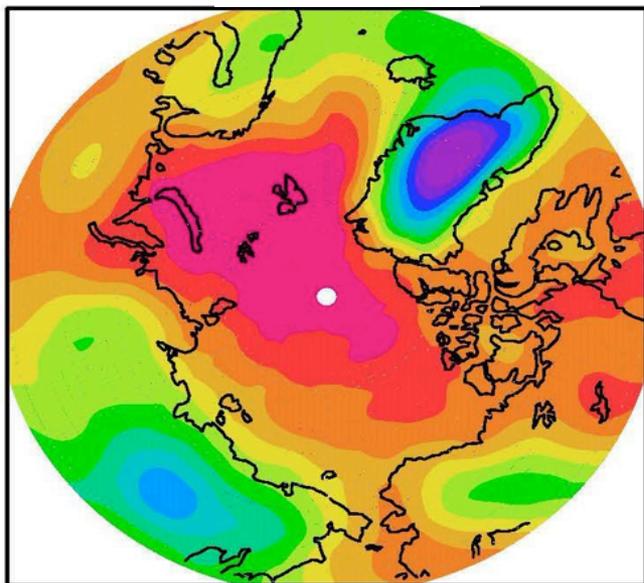
Cloud FB (LW)



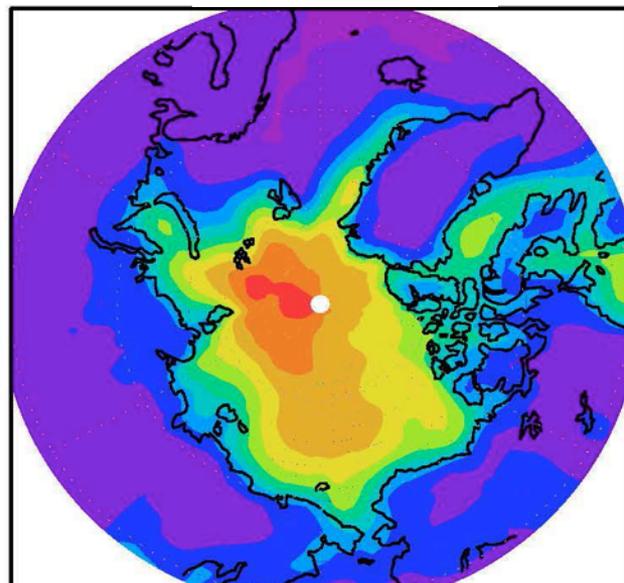
Cloud FB (SW)



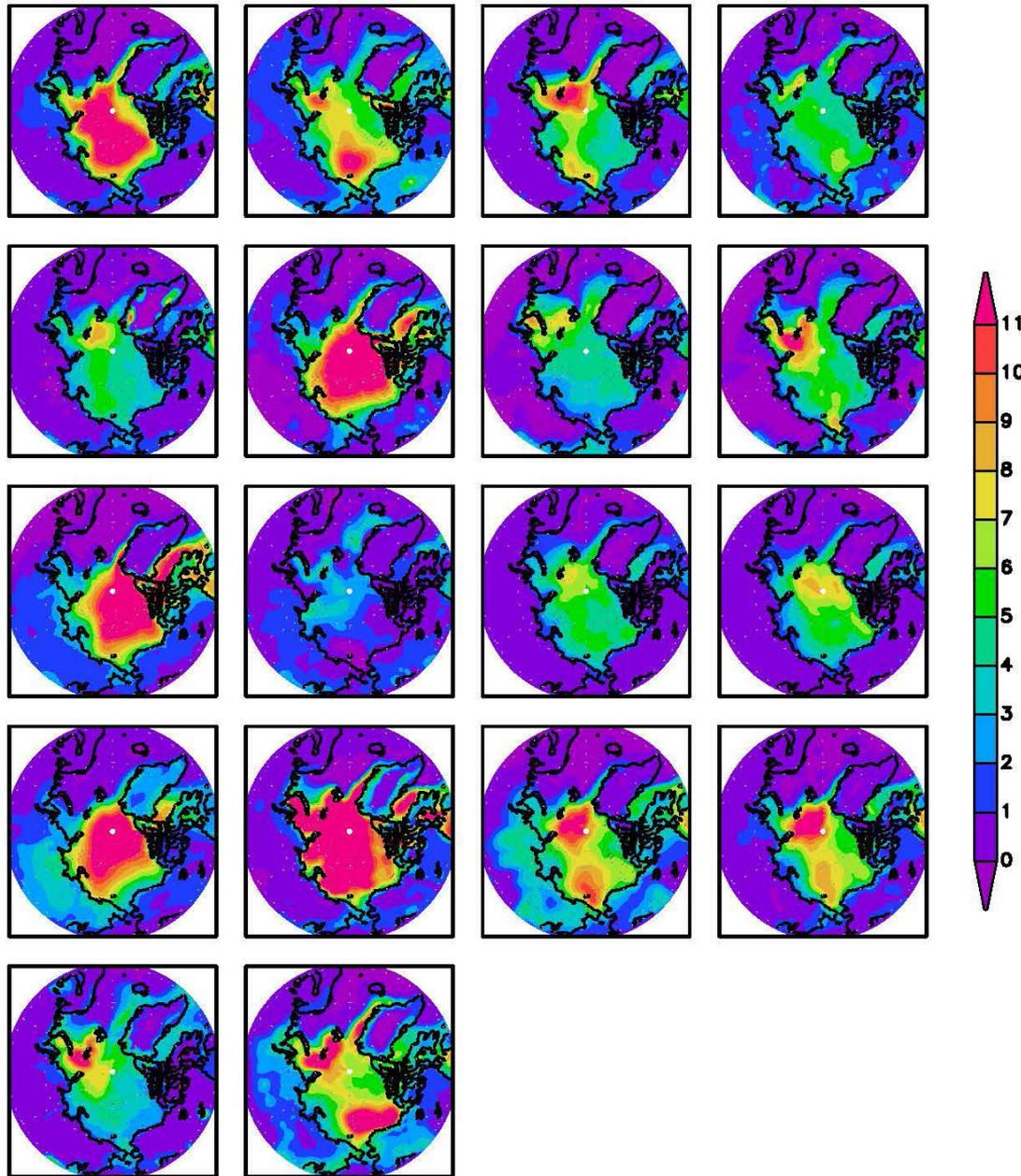
Water Vapor



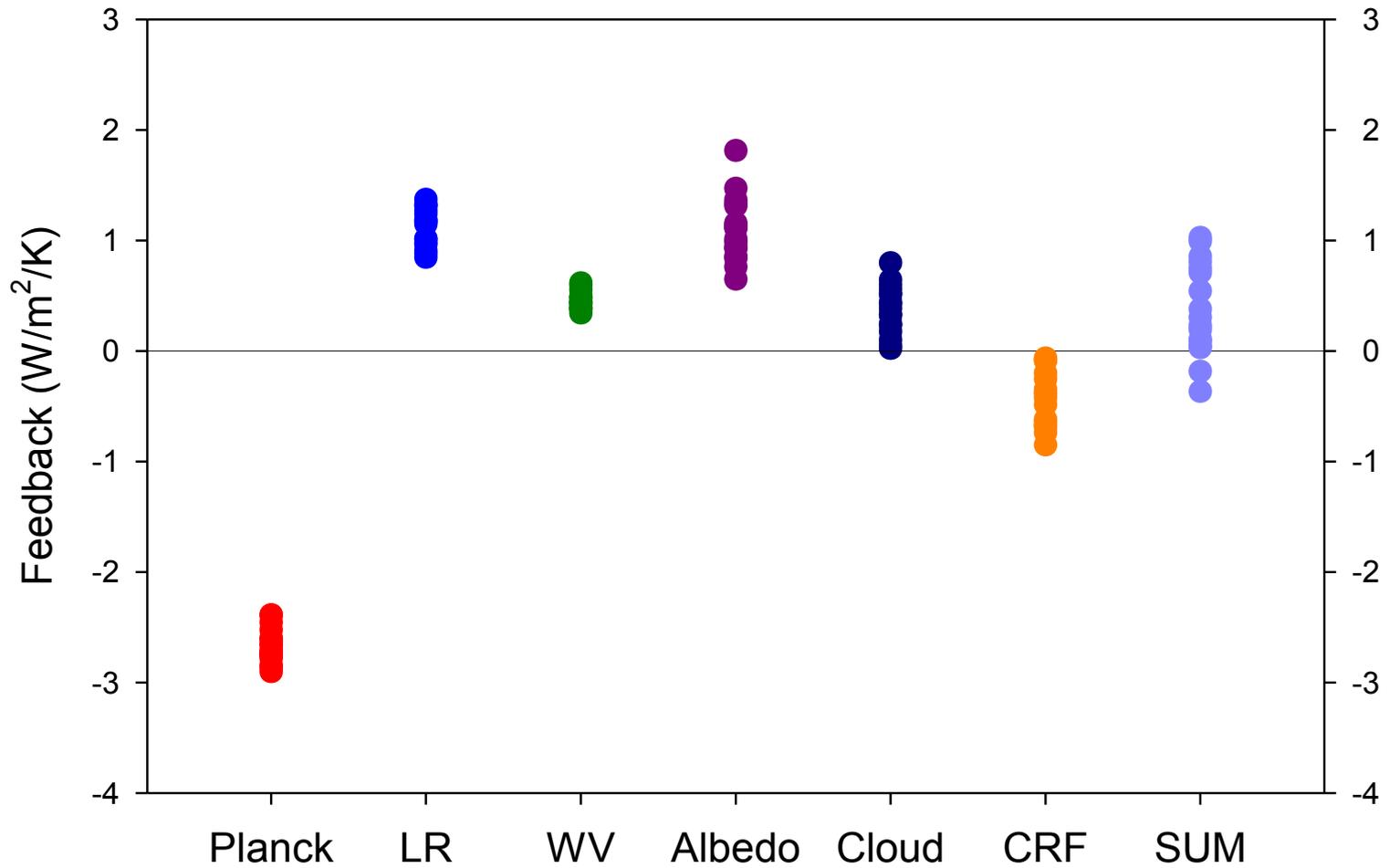
Surface Albedo



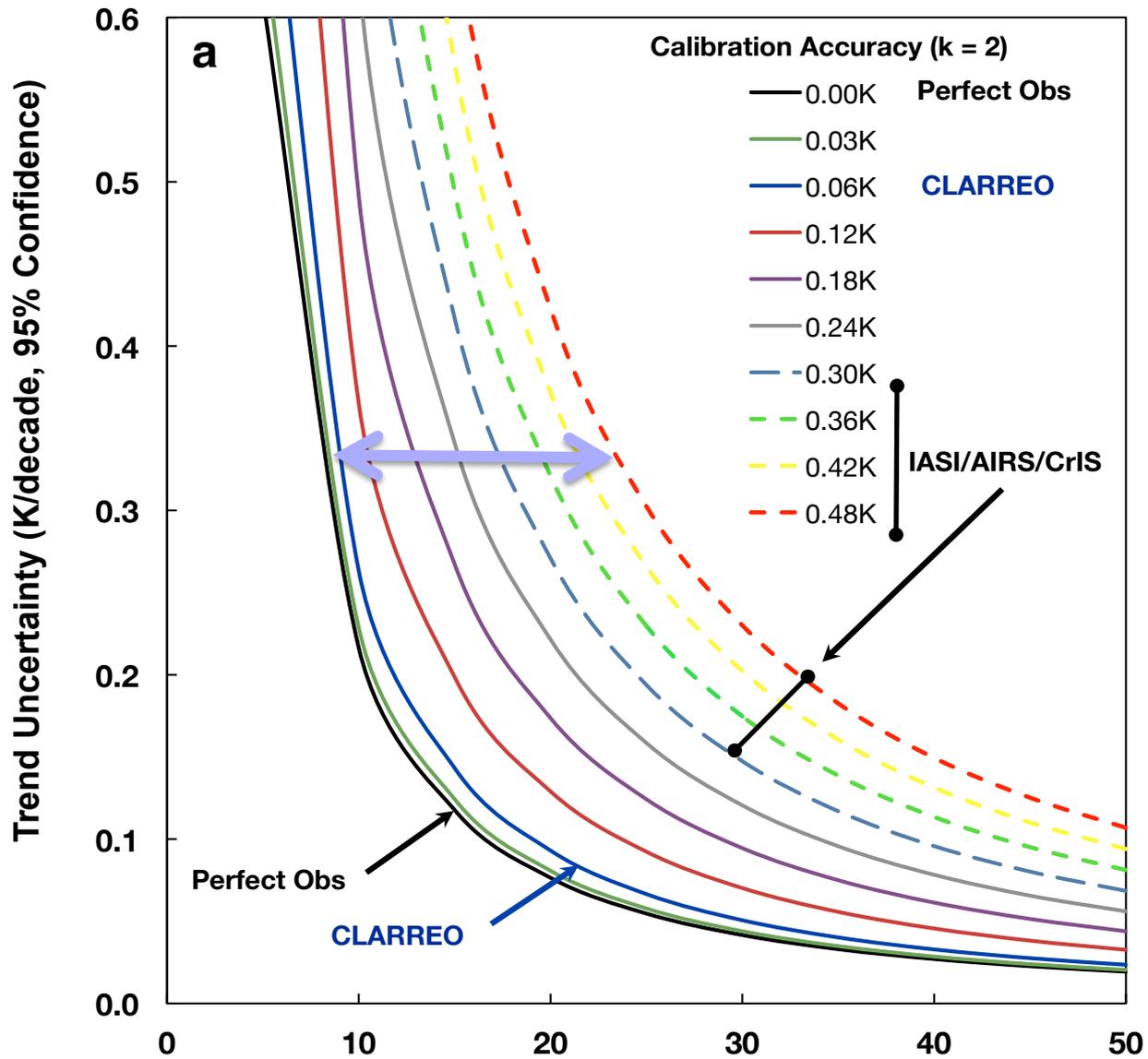
Surface Albedo Feedback



Arctic Mean



- Arctic feedbacks very different than global feedbacks.

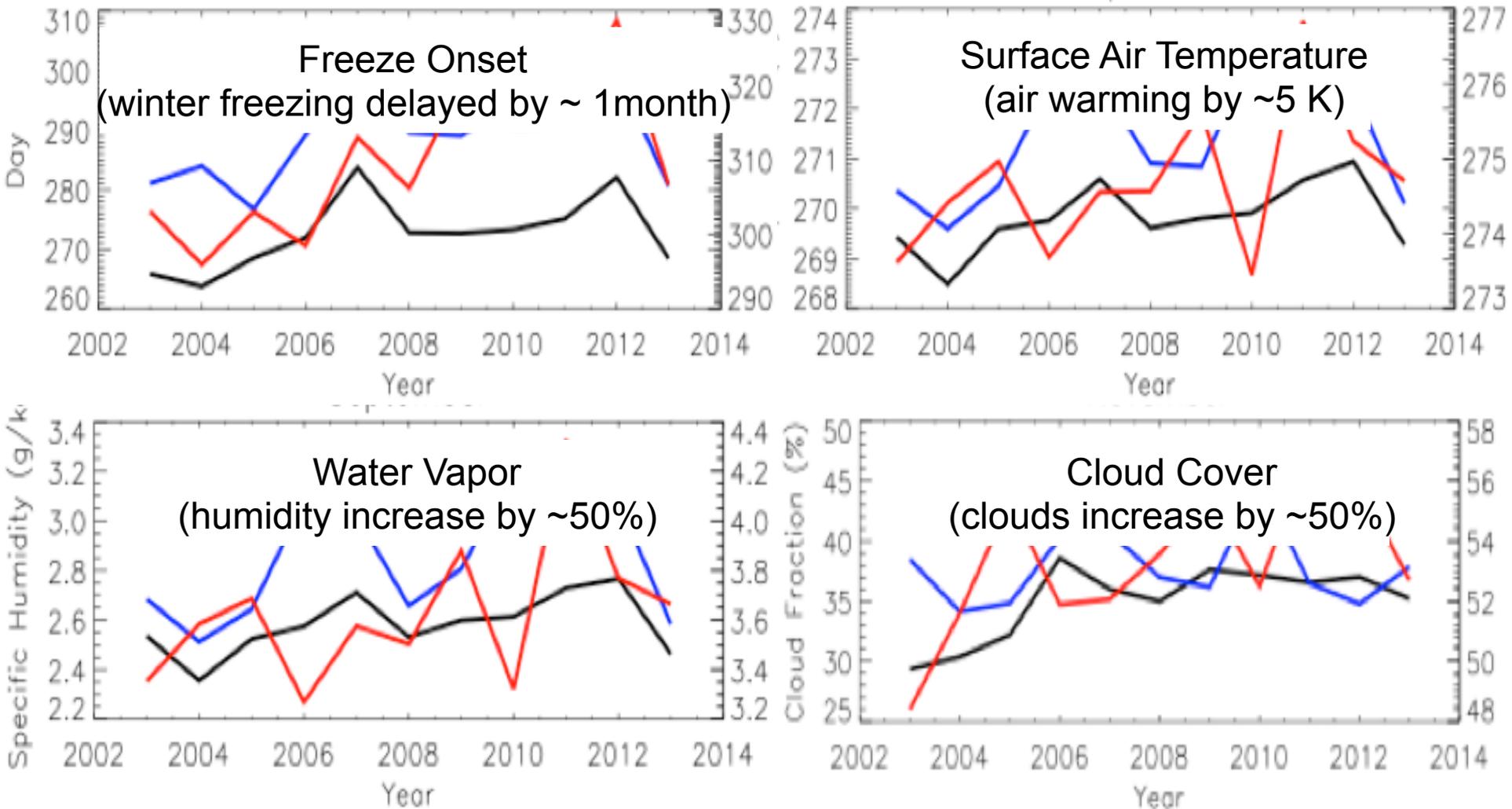


A decadal trend from CLARREO is as reliable as ~30 years of AIRS data

What can you see from a single decade from AIRS?

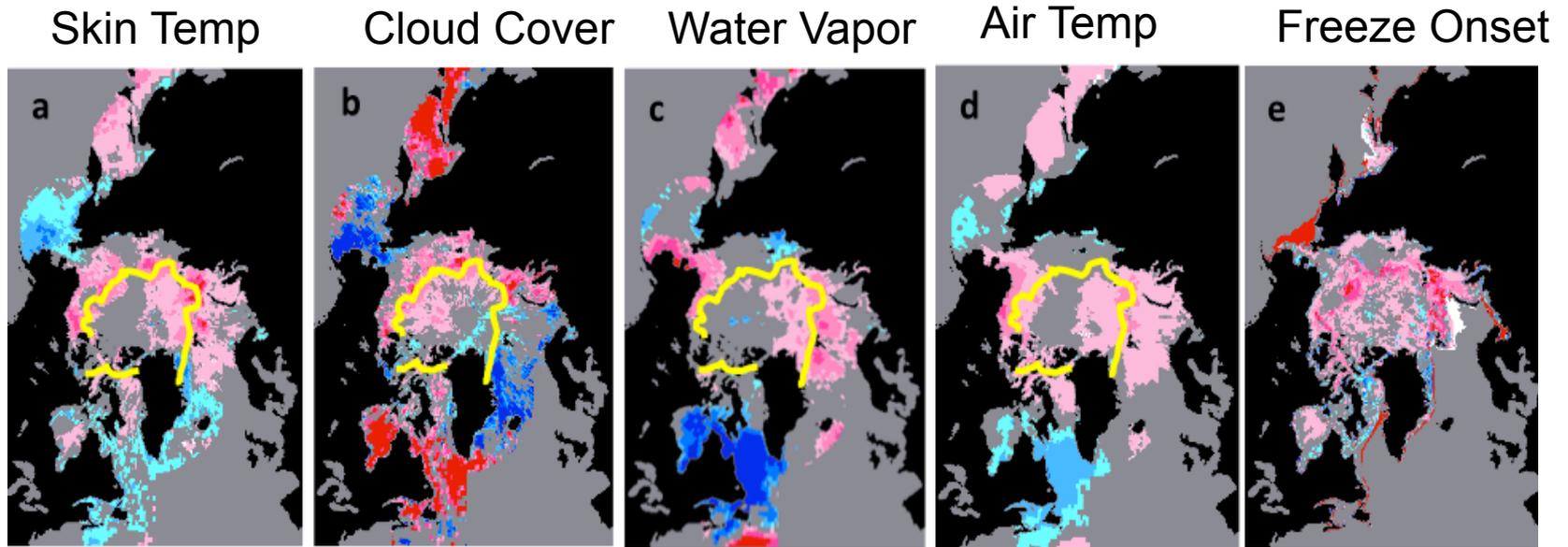
— Arctic Ocean — Chukchi/Beaufort Seas — Kara/Barents Seas

Stroeve et al. (2015)

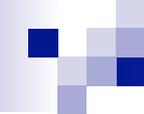


What can you see from a single decade from AIRS?

Stroeve et al. (2015)



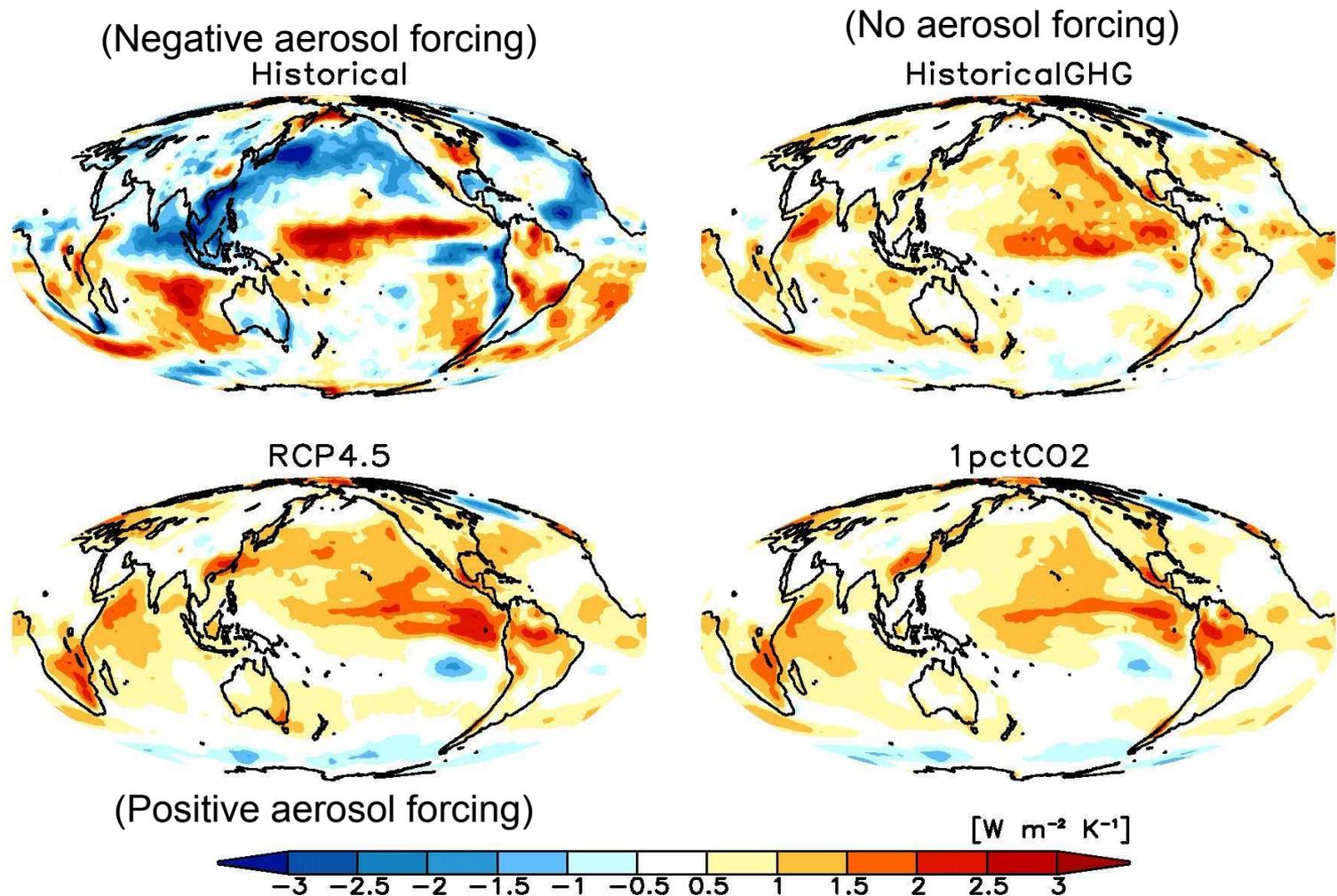
a, d, e	-0.4	-0.2	0.0	0.2	0.4		
b	-6	-4	-2	0	2	4	6
c	-0.2	-0.1	0.0	0.1	0.2		



Next Steps

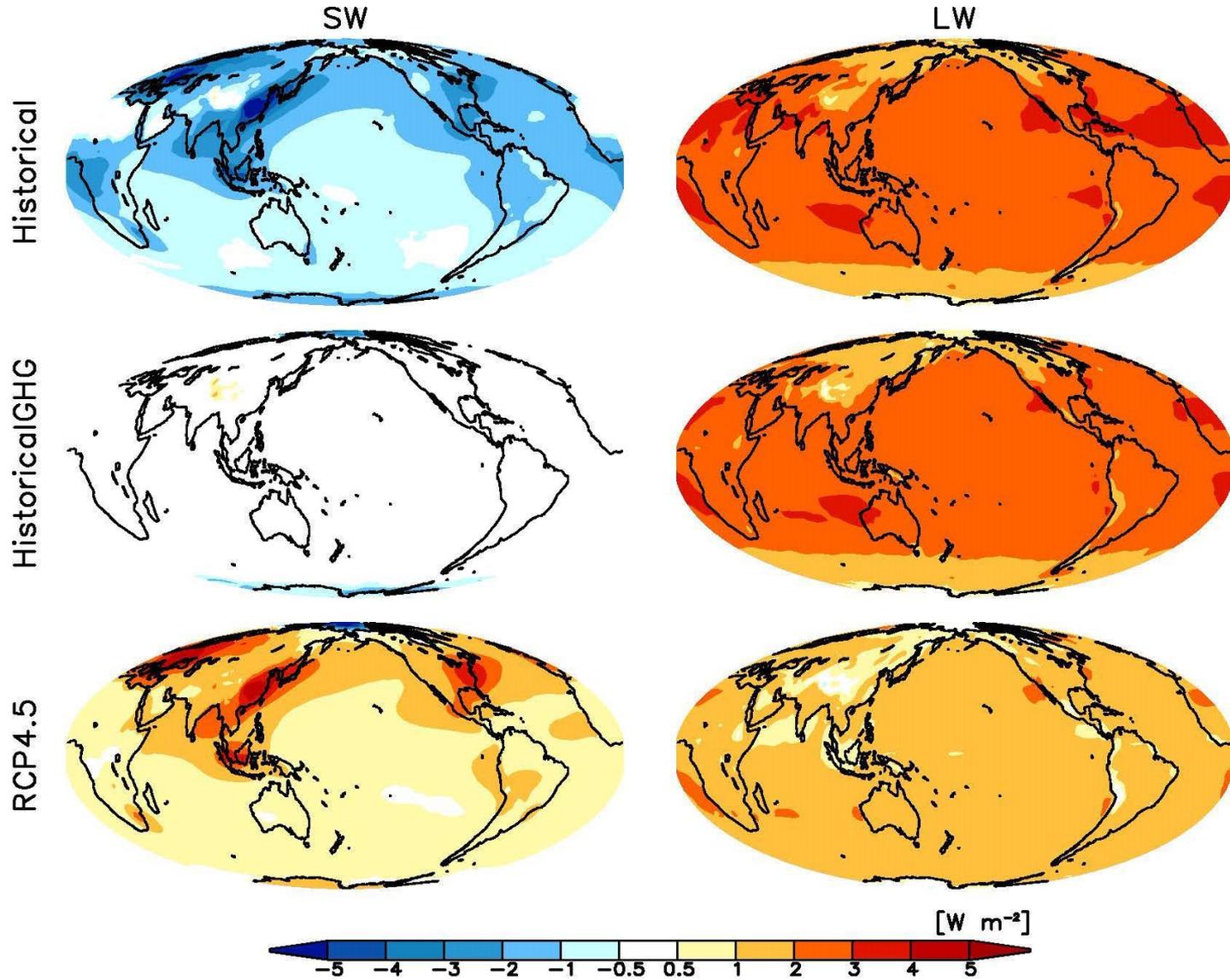
- Estimate feedback strengths from observed changes over satellite record
- Compare across observational data sets (AIRS, CERES, reanalyses, etc.)
- Compare to CMIP5 models
- Examine coupling to meridional energy transports

CMIP5 Ensemble-Mean Cloud Feedback



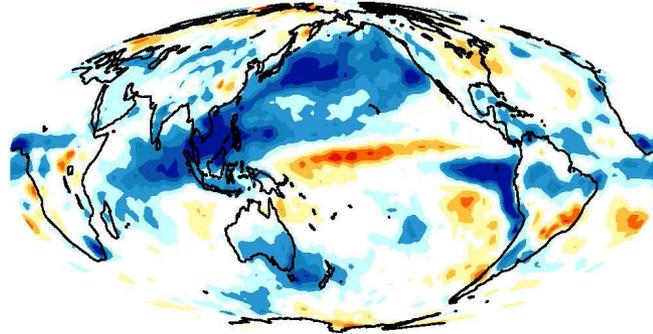
- Aerosol-cloud interactions significantly alter the cloud feedback.
- These are potentially “fast” cloud changes detectable by CLARREO.

Clear-sky Forcing



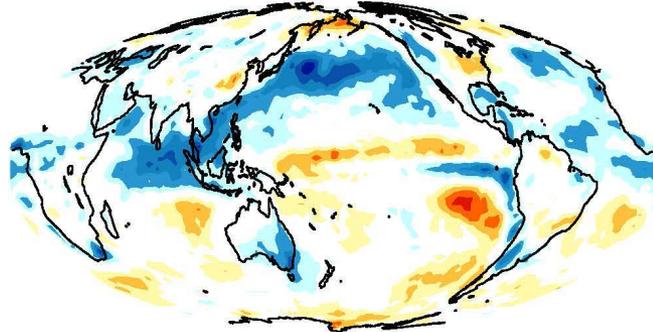
Aerosol-mediated Cloud Response

Historical



Derived from
Radiative Kernels

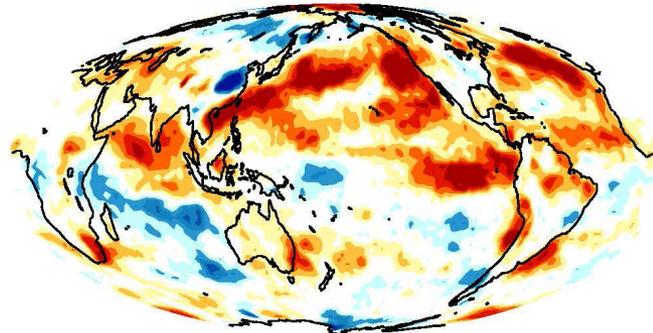
Historical – HistoricalGHG



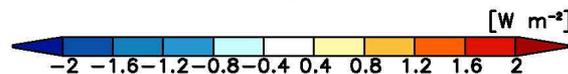
Historical “Truth”

All 3 show non-local
aerosol-induced
cloud changes

RCP4.5

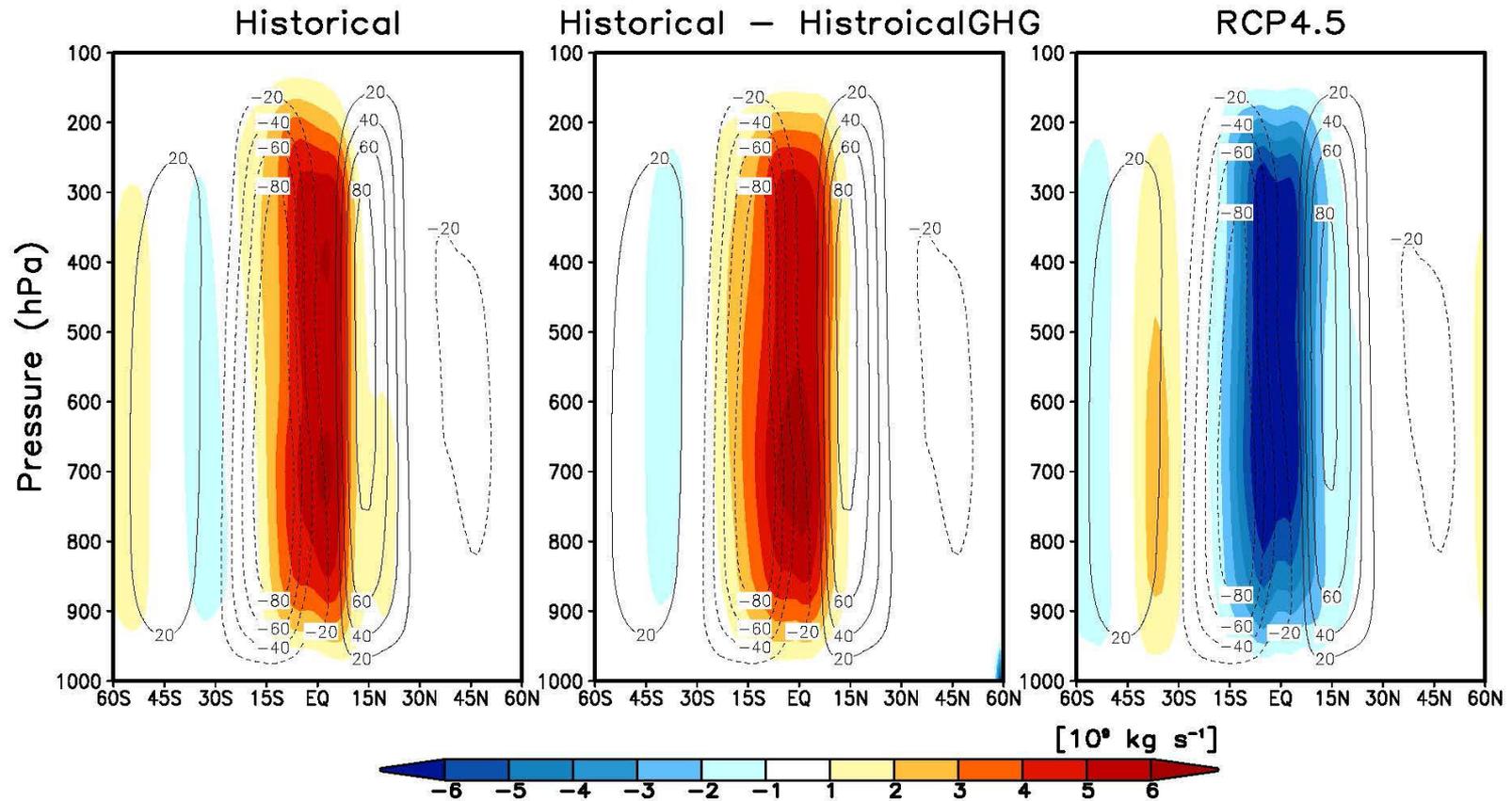


Derived from
Radiative Kernels



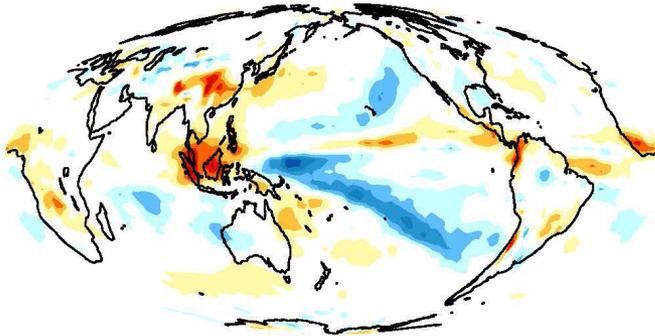
Aerosol-mediated Circulation Response

Historical “Truth”

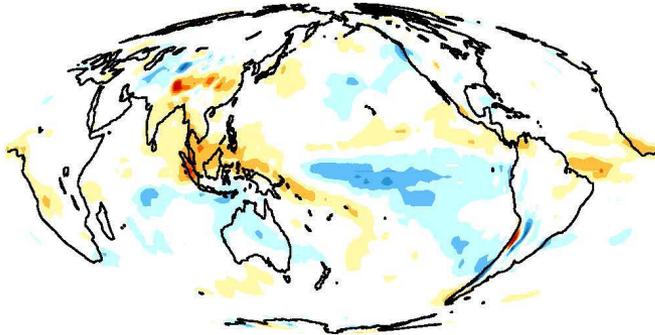


Aerosol-mediated Circulation Response (ω_{500})

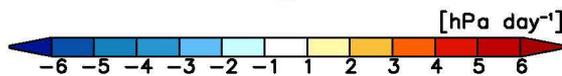
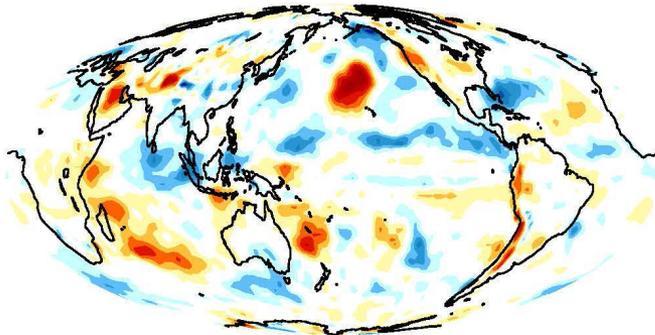
Historical



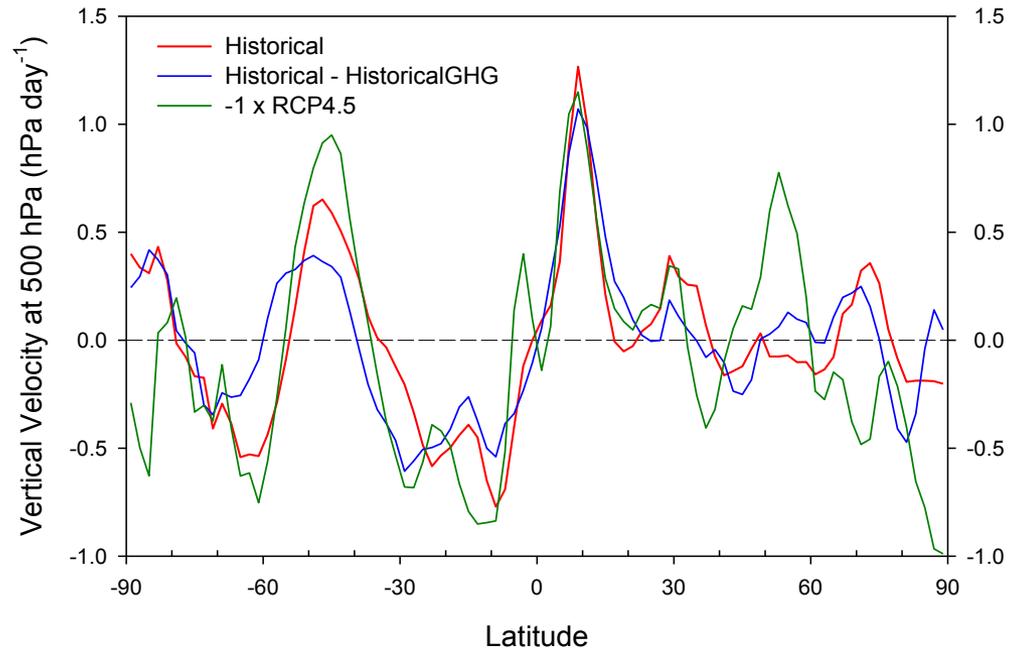
Historical - HistoricalGHG



RCP4.5



Zonal-mean $\Delta\omega_{500}$



- Aerosol radiative interactions force changes in energy transport which drive remote changes in clouds through changes in vertical velocity ...
- These cloud changes occur on the same timescale as aerosol forcing.